
AbSciCon
2019

1
00:00:00,790 --> 00:00:07,320
[Music]

2
00:00:11,950 --> 00:00:08,850
[Applause]

3
00:00:13,930 --> 00:00:11,960
hi everyone thanks for inviting me to

4
00:00:16,260 --> 00:00:13,940
talk at this session I'm really excited

5
00:00:18,130 --> 00:00:16,270
to be here so here we have dots

6
00:00:20,200 --> 00:00:18,140
representing locations where we've

7
00:00:23,140 --> 00:00:20,210
actually recovered methane hydrate all

8
00:00:26,080 --> 00:00:23,150
over the planet the stars are special

9
00:00:27,820 --> 00:00:26,090
spots that I've personally been to out

10
00:00:29,259 --> 00:00:27,830
on the ships recovering hydrate or

11
00:00:32,170 --> 00:00:29,269
collecting low logs which is my

12
00:00:34,570 --> 00:00:32,180
specialty and you can see lots of things

13
00:00:36,490 --> 00:00:34,580

about this one for one we see find a lot

14
00:00:39,040 --> 00:00:36,500
of hydrate hugging continental margins

15
00:00:41,110 --> 00:00:39,050
because what causes hydrate to be there

16
00:00:44,260 --> 00:00:41,120
is organic matter and it's biotic in

17
00:00:47,590 --> 00:00:44,270
origin almost all hydrates we do have on

18
00:00:48,760 --> 00:00:47,600
planet Earth our biotic except for just

19
00:00:50,740 --> 00:00:48,770
a few years ago there was this paper

20
00:00:53,979 --> 00:00:50,750
published about this hydrate office fall

21
00:00:56,709 --> 00:00:53,989
barred that we think is a biotic in

22
00:00:59,229 --> 00:00:56,719
origin so that's the little black swan

23
00:01:01,840 --> 00:00:59,239
we just heard about in Australia in the

24
00:01:03,869 --> 00:01:01,850
last session but basically if you

25
00:01:07,029 --> 00:01:03,879
haven't seen any hydrate I put in this

26
00:01:08,770 --> 00:01:07,039
video that I love to show all over the

27
00:01:10,900 --> 00:01:08,780
world who you're looking at hydrate

28
00:01:14,529 --> 00:01:10,910
burning hydrate is really concentrated

29
00:01:16,570 --> 00:01:14,539
methane surrounded by a water lattice it

30
00:01:19,270 --> 00:01:16,580
looks like frozen ice it looks like snow

31
00:01:21,160 --> 00:01:19,280
and people are interested in it

32
00:01:24,609 --> 00:01:21,170
economically as a potential form of

33
00:01:26,139 --> 00:01:24,619
natural gas and also maybe a really

34
00:01:29,380 --> 00:01:26,149
large component of the Earth's carbon

35
00:01:33,639 --> 00:01:29,390
cycle because it may contain 15 to 40

36
00:01:35,260 --> 00:01:33,649
percent of Earth's carbon so that's why

37
00:01:37,210 --> 00:01:35,270
I study methane hydrate I'm really

38
00:01:40,660 --> 00:01:37,220

interested in how much carbon there is

39
00:01:42,130 --> 00:01:40,670
in hydrates but I also want to come out

40
00:01:44,229 --> 00:01:42,140
to you guys starting in this talk

41
00:01:47,520 --> 00:01:44,239
because I'm not a biologist or a

42
00:01:50,589 --> 00:01:47,530
microbiologist or even a chemist I'm a

43
00:01:53,169 --> 00:01:50,599
petrol physicist and geophysicist and

44
00:01:55,389 --> 00:01:53,179
what that means is I go out on ships I

45
00:01:57,070 --> 00:01:55,399
spend a lot of time looking at this

46
00:01:58,690 --> 00:01:57,080
seismic data you see in the background

47
00:02:00,219 --> 00:01:58,700
here we have the seafloor and all the

48
00:02:03,040 --> 00:02:00,229
layers underneath the seafloor of

49
00:02:05,410 --> 00:02:03,050
sediments and I try to figure out where

50
00:02:07,690 --> 00:02:05,420
we can drill to find gas hydrate and

51
00:02:09,070 --> 00:02:07,700
understand the system and that's a

52
00:02:11,740 --> 00:02:09,080
really rewarding part of what I do

53
00:02:13,990 --> 00:02:11,750
because I if I'm lucky and all of the

54
00:02:16,270 --> 00:02:14,000
stars align and funding I get to go out

55
00:02:18,430 --> 00:02:16,280
and actually drill and figure out if the

56
00:02:19,800 --> 00:02:18,440
ideas I have are working out and making

57
00:02:24,630 --> 00:02:19,810
sense so that's a really

58
00:02:26,309 --> 00:02:24,640
wording part of my work and I really

59
00:02:27,960 --> 00:02:26,319
love thinking about gas hydrate systems

60
00:02:29,850 --> 00:02:27,970
in the subsurface I want to know what

61
00:02:33,809 --> 00:02:29,860
the dimensions are what the features are

62
00:02:35,040 --> 00:02:33,819
what kind of complex systems are

63
00:02:37,290 --> 00:02:35,050

interacting and I actually find that

64
00:02:40,470 --> 00:02:37,300
microbes are a huge part of a gas

65
00:02:41,970 --> 00:02:40,480
hydrate systems on earth before I get to

66
00:02:43,020 --> 00:02:41,980
that I just wanted to do a couple of

67
00:02:46,170 --> 00:02:43,030
definitions because I know we have a

68
00:02:48,809 --> 00:02:46,180
really broad session we find gas

69
00:02:50,790 --> 00:02:48,819
hydrates and marine sediments all over

70
00:02:52,440 --> 00:02:50,800
the world where we have low temperatures

71
00:02:53,820 --> 00:02:52,450
and high pressures here you're looking

72
00:02:55,770 --> 00:02:53,830
at the sea surface down to the sea floor

73
00:02:57,240 --> 00:02:55,780
and then into sediments and you're

74
00:02:59,460 --> 00:02:57,250
looking at the hydrothermal geothermal

75
00:03:00,570 --> 00:02:59,470
gradient so the ocean is cooling all the

76
00:03:03,170 --> 00:03:00,580
way down to the sea floor and then

77
00:03:06,990 --> 00:03:03,180
starting to warm up in the sediments and

78
00:03:09,000 --> 00:03:07,000
if we can put the clathrate or hydrate

79
00:03:10,949 --> 00:03:09,010
stability boundary on top of that you

80
00:03:14,400 --> 00:03:10,959
can see that we start getting clathrates

81
00:03:16,500 --> 00:03:14,410
or hydrates stable at about 300 to 600

82
00:03:19,590 --> 00:03:16,510
meters depending on the temperature of

83
00:03:21,479 --> 00:03:19,600
the ocean and that location and then

84
00:03:23,850 --> 00:03:21,489
they're down stable down to the seafloor

85
00:03:25,650 --> 00:03:23,860
at this location and and then they

86
00:03:28,740 --> 00:03:25,660
become unstable in the sediments because

87
00:03:30,569 --> 00:03:28,750
the geothermal gradient warms up to

88
00:03:34,440 --> 00:03:30,579

where it's too hot for hydrates to be

89
00:03:35,370 --> 00:03:34,450
stable on planet earth however we don't

90
00:03:37,590 --> 00:03:35,380
really find

91
00:03:39,300 --> 00:03:37,600
hydrate in the ocean anywhere we don't

92
00:03:41,550 --> 00:03:39,310
really find much methane in the ocean

93
00:03:43,560 --> 00:03:41,560
all the methane is nearly dissolved

94
00:03:44,130 --> 00:03:43,570
because the ocean is under saturated and

95
00:03:46,470 --> 00:03:44,140
methane

96
00:03:49,170 --> 00:03:46,480
I can imagine really exciting planets

97
00:03:52,110 --> 00:03:49,180
out there where you would have hydrate

98
00:03:54,810 --> 00:03:52,120
forming here and then floating up in the

99
00:03:57,660 --> 00:03:54,820
ocean system icebergs of natural gas

100
00:03:59,759 --> 00:03:57,670
hydrate we don't see that because of the

101
00:04:02,340 --> 00:03:59,769
ocean being under saturated in methane

102
00:04:03,870 --> 00:04:02,350
so we really see hydrate just kind of

103
00:04:06,420 --> 00:04:03,880
forming and this zone here from the

104
00:04:10,860 --> 00:04:06,430
seafloor down to where it becomes too

105
00:04:12,390 --> 00:04:10,870
warm in the sediments another way to

106
00:04:14,580 --> 00:04:12,400
think about that if you don't like the

107
00:04:16,529 --> 00:04:14,590
stability diagram is like here's you and

108
00:04:18,830 --> 00:04:16,539
you're like hanging out on the ocean at

109
00:04:21,029 --> 00:04:18,840
the beach maybe you have a margarita and

110
00:04:22,770 --> 00:04:21,039
over here you have the continental shelf

111
00:04:24,330 --> 00:04:22,780
you don't have any hydrate stable there

112
00:04:26,310 --> 00:04:24,340
but then as you move down on the

113
00:04:27,960 --> 00:04:26,320

continental slope the water column gets

114
00:04:29,790 --> 00:04:27,970
thick enough and so the pressure is high

115
00:04:31,440 --> 00:04:29,800
enough that you have hydrate stable in

116
00:04:33,100 --> 00:04:31,450
the sediments and then the hydrate

117
00:04:38,740 --> 00:04:33,110
stability zone thickens

118
00:04:42,940 --> 00:04:38,750
as you move out of the deeper and deeper

119
00:04:44,350 --> 00:04:42,950
ocean columns however when I when I show

120
00:04:45,490 --> 00:04:44,360
these diagrams and when people first

121
00:04:47,050 --> 00:04:45,500
start thinking about how great stability

122
00:04:48,690 --> 00:04:47,060
I think it gives you this wrong

123
00:04:52,000 --> 00:04:48,700
perception that hydrate is really

124
00:04:54,940 --> 00:04:52,010
homogeneous in the subsea floor system

125
00:04:56,650 --> 00:04:54,950
and that is beyond the truth in fact we

126
00:04:58,720 --> 00:04:56,660
find hydrate systems to be completely

127
00:05:00,820 --> 00:04:58,730
heterogeneous and diverse types and

128
00:05:02,560 --> 00:05:00,830
different types of sediments and that

129
00:05:05,500 --> 00:05:02,570
microbes are contributing differently

130
00:05:09,520 --> 00:05:05,510
and these different systems so here

131
00:05:10,810 --> 00:05:09,530
you're seeing a really new in fact right

132
00:05:12,940 --> 00:05:10,820
now not published

133
00:05:14,650 --> 00:05:12,950
I just communicated with the lead author

134
00:05:16,390 --> 00:05:14,660
of this paper that's going to be coming

135
00:05:18,550 --> 00:05:16,400
out in reviews of geophysics and I think

136
00:05:21,460 --> 00:05:18,560
you guys might be interested in it

137
00:05:23,260 --> 00:05:21,470
she has identified five different types

138
00:05:26,320 --> 00:05:23,270

of hydrate systems in the subsurface

139
00:05:28,930 --> 00:05:26,330
there may be even more one of them is

140
00:05:30,520 --> 00:05:28,940
this sort of classic system where you

141
00:05:32,260 --> 00:05:30,530
have like an anticlinal system that

142
00:05:33,880 --> 00:05:32,270
brings gas up from deep and thermogenic

143
00:05:35,290 --> 00:05:33,890
gas and it moves through the hydrate

144
00:05:37,090 --> 00:05:35,300
system and maybe creates a sort of

145
00:05:40,720 --> 00:05:37,100
fractures here and then you actually

146
00:05:42,160 --> 00:05:40,730
have gas moving into the ocean that's

147
00:05:44,080 --> 00:05:42,170
like the kind of classic one that's

148
00:05:46,030 --> 00:05:44,090
really easy for us to identify and with

149
00:05:48,280 --> 00:05:46,040
fact we know the most about that system

150
00:05:49,540 --> 00:05:48,290
but there are so many other systems that

151
00:05:53,590 --> 00:05:49,550
we find in the subsurface when we

152
00:05:55,360 --> 00:05:53,600
actually go out to drill there another

153
00:05:57,430 --> 00:05:55,370
one that's kind of like more petroleum

154
00:05:58,870 --> 00:05:57,440
and more typical for like a kind of

155
00:06:01,390 --> 00:05:58,880
petroleum system where you have gas

156
00:06:03,850 --> 00:06:01,400
moving again from below but this time in

157
00:06:05,740 --> 00:06:03,860
a more permeable on sedimentary layer

158
00:06:07,660 --> 00:06:05,750
like a sandwich system and the other you

159
00:06:09,430 --> 00:06:07,670
have gas below and hydrate above and

160
00:06:11,710 --> 00:06:09,440
then we had this like kind of

161
00:06:13,420 --> 00:06:11,720
confounding system that we've just

162
00:06:15,520 --> 00:06:13,430
started to find over the last decade

163
00:06:18,430 --> 00:06:15,530

where we found hydrate at high

164
00:06:20,590 --> 00:06:18,440
concentrations in these thin sands that

165
00:06:22,510 --> 00:06:20,600
were far far removed from the base of

166
00:06:24,310 --> 00:06:22,520
the hydrate stability zone and like how

167
00:06:26,260 --> 00:06:24,320
did the hydrate even get there that was

168
00:06:28,360 --> 00:06:26,270
a very confusing thing for us I'd like

169
00:06:30,070 --> 00:06:28,370
to talk about a model that I put

170
00:06:33,340 --> 00:06:30,080
together with co-author Alberto

171
00:06:35,500 --> 00:06:33,350
Malandrino lamont-doherty that shows how

172
00:06:38,170 --> 00:06:35,510
you can get really high saturations of

173
00:06:38,890 --> 00:06:38,180
hydrate and sand and I was just talking

174
00:06:41,050 --> 00:06:38,900
to Megan

175
00:06:42,180 --> 00:06:41,060
Ellen Madden yesterday about hydrates on

176
00:06:44,340 --> 00:06:42,190
Mars and like

177
00:06:46,020 --> 00:06:44,350
definitely coarse-grained systems there

178
00:06:49,800 --> 00:06:46,030
as well but so you could have this kind

179
00:06:51,630 --> 00:06:49,810
of system happening on other planets so

180
00:06:53,430 --> 00:06:51,640
here we have sand at the top and we have

181
00:06:55,440 --> 00:06:53,440
mud you can just think of this as mud

182
00:06:56,490 --> 00:06:55,450
and all the gray and and we have a

183
00:06:59,310 --> 00:06:56,500
couple of different things happening

184
00:07:00,900 --> 00:06:59,320
first we have the solubility you have to

185
00:07:03,990 --> 00:07:00,910
reach so the amount of dissolved methane

186
00:07:05,910 --> 00:07:04,000
you have to have to get free gas out of

187
00:07:08,190 --> 00:07:05,920
the system in this dash line and then

188
00:07:10,170 --> 00:07:08,200

the excess amount you have to make in

189
00:07:11,910 --> 00:07:10,180
fine-grained sediments because the pores

190
00:07:15,300 --> 00:07:11,920
are super tiny so you actually have to

191
00:07:17,430 --> 00:07:15,310
take more methane to get methane to come

192
00:07:19,140 --> 00:07:17,440
out of solution and become free gas so

193
00:07:21,000 --> 00:07:19,150
there's this difference here and then

194
00:07:23,010 --> 00:07:21,010
and then on top of this I haven't drawn

195
00:07:25,380 --> 00:07:23,020
like a potential dissolved methane

196
00:07:28,770 --> 00:07:25,390
profile well in this system we have

197
00:07:30,240 --> 00:07:28,780
achieved enough methane down here for

198
00:07:32,340 --> 00:07:30,250
the sand but we don't have any sand so

199
00:07:34,820 --> 00:07:32,350
over here we have literally no hydrate

200
00:07:37,620 --> 00:07:34,830
no hydrate yet just dissolved methane

201
00:07:39,870 --> 00:07:37,630
and then if we move the sand down over

202
00:07:42,150 --> 00:07:39,880
time due to sedimentation and compaction

203
00:07:44,160 --> 00:07:42,160
the sand would eventually reach that

204
00:07:46,830 --> 00:07:44,170
higher dissolved methane concentration

205
00:07:48,450 --> 00:07:46,840
and bang you have hydrate and forming

206
00:07:50,040 --> 00:07:48,460
the Hydra actually lowers the dissolve

207
00:07:51,450 --> 00:07:50,050
methane concentration and so that you

208
00:07:53,100 --> 00:07:51,460
have higher dissolved methane

209
00:07:55,110 --> 00:07:53,110
concentrations around it so you actually

210
00:07:57,030 --> 00:07:55,120
member the diffusive flocks of methane

211
00:07:59,580 --> 00:07:57,040
coming from fine-grained or muddy

212
00:08:01,080 --> 00:07:59,590
sediments into the sand system and it's

213
00:08:02,250 --> 00:08:01,090

a continuous diffusive flux and if you

214
00:08:03,810 --> 00:08:02,260
got my groups around that you're

215
00:08:06,270 --> 00:08:03,820
continuing to create more and more

216
00:08:07,470 --> 00:08:06,280
methane and more and more methane goes

217
00:08:08,850 --> 00:08:07,480
into the sand creating more and more

218
00:08:11,159 --> 00:08:08,860
hydrate and you can get really high

219
00:08:12,870 --> 00:08:11,169
hydrate saturation without any amount of

220
00:08:15,360 --> 00:08:12,880
methane hydrate actually forming in the

221
00:08:17,100 --> 00:08:15,370
fine-grained sediments and then you can

222
00:08:18,750 --> 00:08:17,110
also have even more developed systems

223
00:08:21,300 --> 00:08:18,760
where you may have even more methane

224
00:08:24,270 --> 00:08:21,310
being generated as you move the system

225
00:08:25,740 --> 00:08:24,280
down and then you may see hydrate also

226
00:08:26,850 --> 00:08:25,750
forming in the fine-grained mud

227
00:08:29,640 --> 00:08:26,860
surrounding it and then this like

228
00:08:30,990 --> 00:08:29,650
hydrate free zone and then more hydrate

229
00:08:32,339 --> 00:08:31,000
in the sand and then another hydrate

230
00:08:35,070 --> 00:08:32,349
free zone so you can get these really

231
00:08:37,200 --> 00:08:35,080
heterogeneous distributions just based

232
00:08:40,459 --> 00:08:37,210
on simple things like differences in

233
00:08:43,500 --> 00:08:40,469
solubility between marine muds and sands

234
00:08:45,360 --> 00:08:43,510
okay so I hit on a couple of these

235
00:08:47,640 --> 00:08:45,370
systems another really interesting

236
00:08:50,670 --> 00:08:47,650
system that we've identified in the

237
00:08:53,900 --> 00:08:50,680
subsurface is is this fractured system

238
00:08:55,820 --> 00:08:53,910

over here these are methane hydrates

239
00:08:58,570 --> 00:08:55,830
forming and fractures and marine mods

240
00:09:01,430 --> 00:08:58,580
there near-vertical they are

241
00:09:03,650 --> 00:09:01,440
interestingly forming in layers so

242
00:09:06,050 --> 00:09:03,660
unlike this system over here which makes

243
00:09:08,300 --> 00:09:06,060
sense we've got gas coming up and things

244
00:09:11,240 --> 00:09:08,310
are fracturing and methane is coming

245
00:09:12,860 --> 00:09:11,250
everywhere why why was the hydrate in

246
00:09:15,980 --> 00:09:12,870
fractures here and then why is it

247
00:09:17,600 --> 00:09:15,990
forming in these really large layers I'm

248
00:09:18,950 --> 00:09:17,610
not gonna form talk about the fracture

249
00:09:20,960 --> 00:09:18,960
formation here but I'm happy to check

250
00:09:24,470 --> 00:09:20,970
chat about someone chat with other

251
00:09:26,330 --> 00:09:24,480
people about that but I am gonna talk

252
00:09:29,870 --> 00:09:26,340
about those really large layers of

253
00:09:31,580 --> 00:09:29,880
hydrate in marine mud okay so this is

254
00:09:32,750 --> 00:09:31,590
some work I did with a Jess Holman she's

255
00:09:35,480 --> 00:09:32,760
now at J and s science in New Zealand

256
00:09:36,950 --> 00:09:35,490
she did all this mapping of a seismic

257
00:09:41,420 --> 00:09:36,960
section that we had in the Gulf of

258
00:09:42,800 --> 00:09:41,430
Mexico and we tied well log data that I

259
00:09:45,230 --> 00:09:42,810
have in these two sites and sorry that's

260
00:09:48,710 --> 00:09:45,240
a little sliced off there at the top and

261
00:09:51,350 --> 00:09:48,720
we were able to identify not just one

262
00:09:54,050 --> 00:09:51,360
layer but three layers where gas hydrate

263
00:09:56,450 --> 00:09:54,060

appeared to be and fractures extending

264
00:09:58,280 --> 00:09:56,460
kilometers so here's a kilometer here

265
00:10:01,010 --> 00:09:58,290
you guys can see so this is like eight

266
00:10:04,700 --> 00:10:01,020
kilometers of gas hydrate and layers

267
00:10:06,260 --> 00:10:04,710
over this basic so that was really

268
00:10:08,810 --> 00:10:06,270
interesting like why is the hydrate

269
00:10:10,400 --> 00:10:08,820
forming that way you can also notice

270
00:10:12,410 --> 00:10:10,410
when you look at this that it almost

271
00:10:13,640 --> 00:10:12,420
looks like there's a cycle like boo

272
00:10:15,770 --> 00:10:13,650
hydrate here

273
00:10:17,810 --> 00:10:15,780
no hydrate in this white spot hydrate

274
00:10:19,700 --> 00:10:17,820
here no hydrate again and so this

275
00:10:20,930 --> 00:10:19,710
sequester I was like chatting with some

276
00:10:23,530 --> 00:10:20,940
people out of meeting and they were like

277
00:10:26,840 --> 00:10:23,540
I bet that's related to glacial cycles

278
00:10:28,670 --> 00:10:26,850
and so organic matter deposition can be

279
00:10:31,190 --> 00:10:28,680
higher or lower during different periods

280
00:10:32,570 --> 00:10:31,200
of time and also glacial cycles are

281
00:10:36,650 --> 00:10:32,580
really affected that organic matter

282
00:10:38,300 --> 00:10:36,660
distribution so we looked at sea level

283
00:10:40,100 --> 00:10:38,310
high stands or low chance another way

284
00:10:42,350 --> 00:10:40,110
you can think about that is just low sea

285
00:10:43,520 --> 00:10:42,360
level and high sea level so when sea

286
00:10:45,620 --> 00:10:43,530
level is low you actually get more

287
00:10:48,110 --> 00:10:45,630
organic matter far out into that sort of

288
00:10:49,670 --> 00:10:48,120

deep water system and I'm sorry I showed

289
00:10:51,740 --> 00:10:49,680
you the map over here this this is

290
00:10:54,860 --> 00:10:51,750
really deep where we're at like 2000

291
00:10:56,690 --> 00:10:54,870
meters of water so to get more organic

292
00:10:59,480 --> 00:10:56,700
matter out there we want to have sieve a

293
00:11:02,900 --> 00:10:59,490
lot of ol low and so when sea level is

294
00:11:05,270 --> 00:11:02,910
low we get higher organic matter

295
00:11:06,090 --> 00:11:05,280
distribution so we took the data that

296
00:11:07,920 --> 00:11:06,100
we've had at the

297
00:11:10,650 --> 00:11:07,930
well log three we took an industry well

298
00:11:12,780 --> 00:11:10,660
we had some bio strat information that

299
00:11:14,189 --> 00:11:12,790
gave us some ideas about the approximate

300
00:11:17,670 --> 00:11:14,199
age of the sediments and we were able to

301
00:11:19,319 --> 00:11:17,680
fit a model where we created the amount

302
00:11:22,410 --> 00:11:19,329
of gas hydrate we thought should be in

303
00:11:25,350 --> 00:11:22,420
those layers based on the sea level

304
00:11:26,970 --> 00:11:25,360
Highland stands at low stands and we

305
00:11:28,920 --> 00:11:26,980
think we're able to match things pretty

306
00:11:30,780 --> 00:11:28,930
well to what actual data we measured in

307
00:11:32,100 --> 00:11:30,790
the whole so this is our resistivity

308
00:11:34,040 --> 00:11:32,110
logs and they can give us an idea of

309
00:11:36,629 --> 00:11:34,050
where we have natural gas hydrate and

310
00:11:37,860 --> 00:11:36,639
you can see we have found hydrate here

311
00:11:39,180 --> 00:11:37,870
and the pink hydrate here in the pink

312
00:11:41,069 --> 00:11:39,190
and here's what our model says we should

313
00:11:43,110 --> 00:11:41,079

have and so there's a bottom part from

314
00:11:45,210 --> 00:11:43,120
about 250 to 400 is matching really well

315
00:11:48,389 --> 00:11:45,220
and we did that in a neighboring role we

316
00:11:50,790 --> 00:11:48,399
have a different bio strat age and again

317
00:11:52,379 --> 00:11:50,800
it was matching really really well so

318
00:11:54,210 --> 00:11:52,389
those cycles that we were seeing before

319
00:11:56,910 --> 00:11:54,220
we now have this hypothesis that they're

320
00:11:58,680 --> 00:11:56,920
related to glacial cycles and are

321
00:12:02,850 --> 00:11:58,690
influenced by the amount of organic

322
00:12:05,100 --> 00:12:02,860
matter that's deposited okay so in

323
00:12:07,410 --> 00:12:05,110
summary methane clathrate hydrates

324
00:12:09,720 --> 00:12:07,420
systems on earth hydrate below the sea

325
00:12:11,970 --> 00:12:09,730
floor is really complex system and it's

326
00:12:13,650 --> 00:12:11,980
a heterogeneous and distribution and I

327
00:12:17,249 --> 00:12:13,660
think that microbes play a huge role in

328
00:12:19,110 --> 00:12:17,259
subsea floor hydrate systems so thank

329
00:12:21,300 --> 00:12:19,120
you very much I just wanted to

330
00:12:23,160 --> 00:12:21,310
acknowledge all of my funding here and

331
00:12:25,319 --> 00:12:23,170
also here's my contact I'm happy to chat

332
00:12:28,180 --> 00:12:25,329
with anyone about how we find hydrates

333
00:12:33,950 --> 00:12:28,190
and subsea floor systems

334
00:12:37,040 --> 00:12:33,960
[Applause]

335
00:12:39,270 --> 00:12:37,050
to the microphone okay good we have

336
00:12:41,250 --> 00:12:39,280
people coming up and there's lots of

337
00:12:48,480 --> 00:12:41,260
seats up here too but if anybody has

338
00:12:50,040 --> 00:12:48,490

questions if nobody has a quick question

339
00:12:51,450 --> 00:12:50,050
I just like to say we just heard that

340
00:12:54,330 --> 00:12:51,460
there may be is a lot of methane on Mars

341
00:12:56,700 --> 00:12:54,340
and you know the systems that would be

342
00:12:58,500 --> 00:12:56,710
really similar to that or he's like

343
00:13:00,540 --> 00:12:58,510
belching systems here we have gas coming

344
00:13:02,430 --> 00:13:00,550
out and also over here in permafrost

345
00:13:04,320 --> 00:13:02,440
systems where a gas is coming out but

346
00:13:06,270 --> 00:13:04,330
that doesn't mean that we don't have all

347
00:13:08,580 --> 00:13:06,280
these other complex systems happening on

348
00:13:10,950 --> 00:13:08,590
Mars as well on earth as well these

349
00:13:12,180 --> 00:13:10,960
systems are the easiest to detect and so

350
00:13:14,340 --> 00:13:12,190
we're just sort of picking up I think

351
00:13:26,270 --> 00:13:14,350
what could the complexity of what could

352
00:13:28,200 --> 00:13:26,280
be in a place like Mars in the different

353
00:13:29,490 --> 00:13:28,210
different regions and whether you've

354
00:13:31,500 --> 00:13:29,500
seen any difference in the in the

355
00:13:32,820 --> 00:13:31,510
isotopic composition depending on the

356
00:13:35,250 --> 00:13:32,830
type of methane clathrate that you've

357
00:13:37,290 --> 00:13:35,260
you've got there okay so yes we have a

358
00:13:39,690 --> 00:13:37,300
geochemist at work and hydrates that

359
00:13:41,520 --> 00:13:39,700
study a lot about isotopic composition

360
00:13:43,650 --> 00:13:41,530
as I mentioned at the beginning like

361
00:13:46,470 --> 00:13:43,660
nearly everything we think is biotic on

362
00:13:48,540 --> 00:13:46,480
Earth but we also have like a lot of

363
00:13:50,790 --> 00:13:48,550

microbial M thermogenic methane that's

364
00:13:52,080 --> 00:13:50,800
forming hydrates in fact though places

365
00:13:54,570 --> 00:13:52,090
where we think we should be finding

366
00:13:56,400 --> 00:13:54,580
hydrate that's thermogenic like this one

367
00:13:58,980 --> 00:13:56,410
where we have seem to have gas coming

368
00:14:00,300 --> 00:13:58,990
from deep and below we are finding over

369
00:14:02,070 --> 00:14:00,310
and over again that those tend to be

370
00:14:04,380 --> 00:14:02,080
more microbial and so we think those may

371
00:14:06,030 --> 00:14:04,390
be reworked microbial systems where the

372
00:14:08,220 --> 00:14:06,040
thermogenic guests coming up from below

373
00:14:12,570 --> 00:14:08,230
and then microbes are then altering that

374
00:14:14,610 --> 00:14:12,580
gas and that's a really new idea but

375
00:14:20,040 --> 00:14:14,620
it's we keep finding it over and over

376
00:14:32,999 --> 00:14:29,910
I so if if this is related to microbes

377
00:14:36,960 --> 00:14:33,009
and you've got this kind of sporadic

378
00:14:38,429 --> 00:14:36,970
distribution how do you explain how do

379
00:14:40,379 --> 00:14:38,439
you explain that interaction I mean

380
00:14:44,100 --> 00:14:40,389
would our microbes gonna be a little

381
00:14:45,479 --> 00:14:44,110
more system at you know ubiquitous yeah

382
00:14:47,519 --> 00:14:45,489
I think it's really the coupling between

383
00:14:48,900 --> 00:14:47,529
where the microbes are living how

384
00:14:51,269 --> 00:14:48,910
they're generating methane and then the

385
00:14:52,769 --> 00:14:51,279
geologic system that's there so like I

386
00:14:54,299 --> 00:14:52,779
was showing where we were getting large

387
00:14:56,549 --> 00:14:54,309
amounts of hydrate in the sand and maybe

388
00:14:58,590 --> 00:14:56,559

not in the muds well the organic matters

389
00:15:00,569 --> 00:14:58,600
in the mud so it's it's moving somehow

390
00:15:02,759 --> 00:15:00,579
and the microbes are making methane

391
00:15:04,139 --> 00:15:02,769
somehow but it's concentrating them in

392
00:15:06,650 --> 00:15:04,149
the sand so maybe the microbes are

393
00:15:09,629 --> 00:15:06,660
living more in the sand or maybe there

394
00:15:11,309 --> 00:15:09,639
and methane is moving and it dissolved

395
00:15:13,559 --> 00:15:11,319
I mean organic matter was moving

396
00:15:16,559 --> 00:15:13,569
dissolved into the sand and creating

397
00:15:20,220 --> 00:15:16,569
that hydrate have you looked at any

398
00:15:22,530 --> 00:15:20,230
sequence stratigraphy - as a predictive

399
00:15:26,429 --> 00:15:22,540
model for this oh that's such a good

400
00:15:28,710 --> 00:15:26,439
question I just wrote a proposal I just

401
00:15:30,720 --> 00:15:28,720
wrote a proposal to like get some more

402
00:15:36,090 --> 00:15:30,730
data and chords from the site where we

403
00:15:39,689 --> 00:15:36,100
did that modeling to look at glacial

404
00:15:40,889 --> 00:15:39,699
cycles involved in microbial methane and

405
00:15:42,359 --> 00:15:40,899
I'm really interested in getting the

406
00:15:43,650 --> 00:15:42,369
sediments from there because I would

407
00:15:45,929 --> 00:15:43,660
really like to understand the sequence

408
00:15:48,509 --> 00:15:45,939
trigger way better and also get much

409
00:15:49,590 --> 00:15:48,519
better age dating so that we might be

410
00:15:53,549 --> 00:15:49,600
able to prove or disprove that